1403 Jordan Cannon, Craig McGowan

Individual muscle contributions to jumping by kangaroo rats using forward dynamics simulation

Kangaroo rats are small bipedal rodents that escape predators using explosive vertical jumping, reaching up to 10 times their standing hip height, by generating large ground reaction forces over a short time period to accelerate the body's center-of-mass. Previous work demonstrates that ankle power dominates joint contributions to jumping but that ankle extensor muscles and elastic energy storage and return by tendon cannot account for the total power observed. Rather, transfer of power from proximal muscles via biarticular ankle extensors likely enable the remarkable power output at the ankle joint. However, individual muscle contributions to vertical jumping by kangaroo rats are unknown and limitations exist when interpreting individual muscle function using in vivo data alone. In this study, we generate a muscle-actuated forward dynamics simulation of kangaroo rat vertical jumping to calculate each muscle's contribution to ground reaction forces, acceleration of the body center-of-mass and other body segments, and transfer of power between body segments. This enables us to determine how energy produced by individual muscles is transferred between segments and delivered to the environment. Our preliminary results suggest that biarticular muscles transfer energy generated by large uniarticular muscles in a proximal-to-distal sequence across the linkage to increase ankle power. Additionally, forward dynamics simulations resolve discrepancies between inverse dynamics analyses and in vivo muscle data by interpreting muscle function in the context of system dynamics.